Trying broadband characterization at home

The pros and cons of increasingly complex home networks

Mario A. Sánchez
John S. Otto
Zachary S. Bischof
Fabián E. Bustamante

Northwestern, EECS

http://aqualab.cs.northwestern.edu
Increasingly complex home networks

- Large growth in quantity/diversity of home network devices
  - Internet-ready devices shipments will surpass **500M units by 2013!**

*iomega NEC*
Increasingly complex home networks

- Large growth in quantity/diversity of home network devices
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Increasingly complex home networks

- Challenges home network usability and resource management
- Complicates broadband characterization at the last meter (e.g., cross traffic)
  - **Dasu**, Netalyzer, Glasnost, …

*Despite increasing home network complexity, we can do broadband characterization from end hosts*
And the good news ...

- Complexity drives Universal Plug and Play (UPnP) adoption to simplify home-network management

- UPnP-enabled gateway can be used to infer cross-traffic

- The problem brings the solution
  - for broadband characterization at home
Roadmap

- Explore the complexity of home networks
  - Number and diversity of devices detected
- Classify devices based on likelihood of generating cross-traffic on the access-link
- Understand dynamics of home device usage
  - When devices are on/off and, if on, when do they exchange data
- Sketch an effective approach to broadband characterization*

*DiCioccio 2011
Measurement methodology

- Measure from Dasu, a platform for broadband benchmarking and network experimentation on end hosts
  - Total over 91k in over 150 countries
  - Our dataset: ≈13K home networks
  - BitTorrent

- Passive
  - Transferred bytes from host (netstat)
  - BitTorrent
  - Cumulative bytes transferred over the access-link (UPnP)

- Active
  - Upload/download throughput using NDT
  - Discovered devices information (UPnP): ≈4.6K home networks
Interpreting UPnP responses...

- *If you don’t respond to UPnP you don’t exist*
  - These devices are not accounted for
  - But we’ll know your network usage

- Same device can announce several UPnP services
65% of homes have at least one device
65% of homes have at least one device
16% of homes have 3 or more

16% of homes have 3 or more networked devices
Not all devices play the same role

- Gateways
- External-facing: talks to the outside world
- Internal-facing: talks within the home network

![Image showing different devices and their facing types]
With complexity, externally-facing devices ...

% homes with an external UPnP device

# announced UPnP devices

- 1 UPnP device: 1.0%
- 2 UPnP devices: 2.6%
- 3 UPnP devices: 6.2%
- 4 UPnP devices: 15.3%
- 5+ UPnP devices: 43.8%

Likelihood increases
As # of devices increases so does the likelihood home gateway supports UPnP
Many opportunities to measure

- “who else is out there”
Many opportunities to measure

- For 85% locations device is alone 10% of time

![Graph showing percentage of homes with different numbers of devices.]

For 50% of samples no other external device is present!

For 20% of samples the host is alone
For broadband characterization
  - No cross-traffic
  - Local cross-traffic from other applications in the host
  - Cross-traffic from other devices

UPnP- enabled gateways help identify different network usage scenarios inside the home network
Usage rather than presence (micro dynamics)

No cross-traffic

BitTorrent \(\equiv\) Netstat \(\equiv\) UPnP

BitTorrent
Other Apps

Host Traffic

Other Devices
Traffic

Home Gateway

Internet
Local cross-traffic from other applications in the host

- BitTorrent
- Other Apps

Netstat

UPnP

Home Gateway

Internet

Other Devices Traffic

Host Traffic

Local cross-traffic from other applications in the host.
Cross-traffic from other devices

BitTorrent ≤ Netstat < UPnP

BitTorrent
Other Apps

Host Traffic

Home Gateway

Other Devices Traffic

Internet
Client is sole responsible for network traffic in access link.
Home alone

- Client is sole responsible for network traffic in access link

![Graph showing network traffic over time]

**BitTorrent ≤ netstat = UPnP**
Home alone

- Client is sole responsible for network traffic in access link
Not alone, but you can tell

- Cross-traffic from other devices

![Graph showing downloaded data over elapsed time]
Not alone, but you can tell

- Cross-traffic from other devices

![Graph showing downloaded data over time with labels: BitTorrent - local, Netstat - local, UPnP - gateway. The graph indicates BitTorrent <= netstat < UPnP.]
Summary

Despite complex home networks we can do broadband characterization from home

- Today’s home network are a complex environments
- While # of devices in the network is high, only a few regularly connect to the Internet
- As # of devices increase, so does the likelihood home gateway supports UPnP
  - For home network management, sure
  - But also for broadband characterization